

**CORK INSTITUTE OF TECHNOLOGY  
INSTITIÚID TEICNEOLAÍOCHTA CHORCAÍ**

**Autumn Examination 2010/2011**

<b>Module Title:      BioAnalytical Science III</b>
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**Module Code:**            **CHEA6003**

**School:**                    Biological Science

**Programme Title:**    Bachelor of Science in Applied Biosciences & Technology – Year 2  
                                 Bachelor of Science (Honours) in Nutrition & Health Science – Year 2  
                                 Bachelor of Science (Honours) in Pharmaceutical Biotechnology – Year 2

**Programme Code:**    **SBIOS\_7\_Y2**  
                                 **SNHSC\_8\_Y2**  
                                 **SPHBI\_8\_Y2**

**External Examiner(s):**    **Dr Alison Gallagher, Dr Jerry Bird, Dr Anne Nelson**  
**Internal Examiner(s):**    **Dr Rosamund Hourihane, Dr M. Lehane , Ms Eva Norris.**

**Instructions:**                    **Attempt BOTH sections A and B. Answer a total of 3 questions. Show all calculations on the answer script.**

**Duration:**            2 Hours

**Sitting:**                    Autumn 2011

**Requirements for this examination:**            Periodic Tables

<p><b>Note to Candidates:</b> Please check the Programme Title and the Module Title to ensure that you have received the correct examination paper. If in doubt please contact an Invigilator.</p>
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## Section A - Section A is compulsory

Attempt any 8 of the following 10 parts. All carry equal marks.

- Q1. (a) Give a description of the electromagnetic spectrum. Include detail about properties of different wavelength regions. What is the wavelength range for the visible part of the electromagnetic spectrum?
- (b) CCDs are frequently used for light detection and measurement. What do the letters CCD stand for? Give a simple description of the structure of a CCD and thereby explain how a CCD measures light intensity.
- (c) Most spectroscopic analysis techniques requires electromagnetic radiation to have *narrow bandwidth*. Explain what 'narrow bandwidth' means. Why is a narrow bandwidth desirable for spectroscopic applications? List three methods/techniques for achieving narrow bandwidth light source.
- (d) In relation to spectroscopy, what is the function of a monochromator? Draw a diagram which illustrates the optical layout of a monochromator that uses a prism.
- (e) Suggest *five* properties of an ideal photo detector.
- (f) Determine the molarity of a solution made by dissolving 20.0 g of NaOH in sufficient water to yield a 482 cm<sup>3</sup> solution.
- (g) Explain briefly three of the following (provide diagrams to support your answer) the following chromatographic terms: retention time (R<sub>t</sub>), Peak Area, Peak Height, capacity factor and co-elution.
- (h) What are the necessary structural features that enable a molecule to fluoresce and what are the means by which such fluorescence can be inadvertently quenched
- (i) In terms of liquid chromatography (LC) and gas chromatography (GC) distinguish between qualitative and quantitative analysis and explain the role of standards in these types of analyses.
- (j) Define the term retention factor (R<sub>f</sub>) as used in Thin Layer Chromatography (TLC) and explain how it is determined practically from a TLC plate.

(8 x 5 marks = 40 Marks)

## Section B

### Attempt two of the following three Questions

- Q2.** (a) Absorption of radiation in the Ultraviolet /visible region results in an electronic transition to an anti-bonding orbital. Inclusion of an auxochrom in the structure of a chromophore may cause some spectral changes.
- (i) Explain briefly what is meant by the underlined terms. (7 marks)
- (ii) Draw a simple, well labelled, energy level diagram illustrating all possible electronic transitions. Identify the most common transitions, justify your selection. (5 marks)
- (iii) Name and explain briefly two possible spectral changes. (3 marks)
- (b) The data outlined in the table below were obtained in the ultraviolet/visible analysis of a number of food samples for glucose content. To this end a series of standard solutions were prepared by literature methods. Their absorbance values were measured at 555nm. Two unknown samples were prepared by similar methods and their absorbance measured at the same wavelength. The results are included in the table too. As can be seen from the table the absorption value obtained for one of the food samples is outside the range of the standards. In order to determine this unknown it was subjected to a 1 in 5 dilution and re-measured. The value obtained for the diluted unknown is also included in the table.

Abs	Concentration gdm <sup>-3</sup>
0.16	0.005
0.56	0.015
0.98	0.025
1.40	0.035
2.00	0.050
0.46	Unknown 1
2.55	Unknown 2
1.60	Diluted unknown 2

- (i) Draw the appropriate calibration curve. (5 marks)
  - (ii) Determine the concentration of glucose in both unknowns in  $\text{gdm}^{-3}$  (4 marks)
  - (iii) Describe how the dilution of unknown 2 may be achieved. (2 marks)
  - (iv) If the concentration of the glucose stock solution is  $0.5\text{gdm}^{-3}$ , what volume of this solution is required to prepare  $50\text{cm}^3$  of the  $0.035\text{gdm}^{-3}$  standard? (4 marks)
- (25 Marks)

### Q3.

- (a) With regard to Liquid chromatography explain the follow terms:
    - i. Eluent
    - ii. Elution
    - iii. Height Equivalent to a Theoretical Plate (HETP)
    - iv. Resolution (12 marks)
  - (b) Discuss the causes of band broadening as represented by the terms in the Van Deemter Equation:
 
$$H = A + B/\mu + C\mu$$
 (10 marks)
  - (c) Discuss practical strategies that may be applied to improve peak shape and the separation of adjacent peaks in Liquid Chromatography. (8 marks)
- (25 Marks)

### Q4.

- (a) Describe the types of stationary phases that are used in normal, reverse phase and ion chromatography (provide sketches to support your answer). (10 marks)
  - (b) Explain the principles of Ion Chromatography in relation to the separation of charged species, giving an account of how the analyte interacts with a suitable mobile phase and stationary phase. (10 marks)
  - (c) Explain the term Ion Selective Electrode (ISE) and list four types of ISE
    - i) Discuss their mechanisms of operation.
    - ii) Identify practical applications and advantages and disadvantages
 (10 marks)
- (25 Marks)